Perspective

Science and Technology:
From Innovation and Knowledge to Implementation

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Our mission at NREL is not simply to perform R&D on renewable energy and energy efficiency technologies, but also to make sure that the innovation and knowledge we generate is taken through implementation to address the nation's energy, environmental, and economic goals. The path from idea to fruition is challenging, and our R&D can face many obstacles on the way.

To help ensure success, we have a management paradigm that takes science and technology from initial concept through a process that enables the concept to reach its final goal. This process includes strategy and plans, hypothesis and verification, delivering R&D accomplishments in technology development, and forming and nurturing partnerships—all ending in the development of a technology that is ready to benefit the nation and the world.

One of our principal measures of success is to win R&D 100 awards, which are presented by *R&D Magazine* to the 100 most technologically significant products and processes of the year. The awards represent an affirmation that our research ideas are being used in the real world to help meet America's needs and that we are meeting our mission. Since 1979, NREL has won 37 of these awards, 31 since 1991.

In 2004, NREL won two more R&D 100 awards (see stories on pages 4–6)—one for lightweight, flexible, copper indium gallium diselenide PV modules; and the other for enzymatic hydrolysis of biomass cellulose to sugars. Both technologies are representative of our R&D management paradigm. Consider the enzymatic hydrolysis technology, which has a long history at NREL. One of the Laboratory's original programs involved the development of technologies to produce alternative fuels from biomass, to relieve America's growing dependence on imported oil. From the beginning, NREL realized that, in the long term, cellulosic biomass presented the largest resource for such alternative fuels. Moreover, enzymatic hydrolysis of cellulose represented the preferred pathway for lowering the cost to where fuels derived from cellulosic biomass could not only be competitive with other alternative fuels but also with petroleum.

NREL subsequently laid out a long-term strategy to develop the enzymatic technology base and meet the cost goals, emphasizing the emerging fields of genetic and protein engineering and enzyme production. The R&D approach under this strategy involved basic research to discover appropriate microorganisms, engineer the variations, and produce those variations. It also involved a parallel effort in applied research and engineering to integrate the microorganisms into hydrolysis and fermentation processes. Once the technology was sufficiently proven, NREL sought partners who could better engineer enzymes and who could efficiently produce the enzymes in quantity. NREL reached a partnership agreement with two of the best in the world—Genencor International and Novozymes Biotech Inc. This NREL/Genencor/Novozymes partnership quickly resulted in technological advances that cut by 20-fold the cost of enzymatic hydrolysis. This is now becoming a "real-world" technology that will help open America's vast biomass resources for the economic production of not only alternative fuels, but also chemicals, plastics, and many other products—while offsetting the use of petroleum.

Today, with its research in nanoscience and nanotechnology (see story on pages 8–17), NREL is facing a situation analogous to that which it faced with enzymatic hydrolysis a decade or so ago. Some of our R&D is still in the basic phase, with hypotheses being formed and tested. But in other avenues of exploration, we are performing applied research and are entering into collaborations and partnerships with universities, institutes, and companies. Nanotechnology is an extremely promising area for energy research and development. If the R&D is managed following our established paradigm, it will lead to a new frontier of energy solutions, which is so important for the nation and the world. As with past and present successes, we are confident that the nanoscience and nanotechnology being researched at the Laboratory today will become the real-world technologies of tomorrow.

This is not just our belief—it is our mission.